

**CLAIMS**

What is claimed is:

1. A natural gas liquid plant, comprising:  
  
a separator that separates a cooled low pressure feed gas into a liquid portion and a vapor portion, wherein the liquid portion is reduced in pressure in a first pressure reduction device, thereby providing refrigeration for a first cooler that cools a low pressure feed gas to form the cooled low pressure feed gas;  
  
wherein at least part of the vapor portion is cooled in a second cooler and reduced in pressure in a second pressure reduction device before entering an absorber as lean absorber reflux; and  
  
wherein the absorber produces an absorber overhead product that provides refrigeration for the second cooler, and wherein the absorber produces an absorber bottoms product that is fed into a demethanizer as lean reflux.
2. The natural gas liquid plant of claim 1 wherein the low pressure feed gas has a pressure of about 300 psig to about 1 000 psig.
3. The natural gas liquid plant of claim 1 wherein a portion of the low pressure feed is cooled in a plurality of side reboilers that are thermally coupled to the demethanizer.
4. The natural gas liquid plant of claim 1 wherein the first pressure reduction device comprises a hydraulic turbine, and wherein the second pressure reduction device comprises a Joule-Thompson valve.
5. The natural gas liquid plant of claim 1 wherein the liquid portion that is reduced in pressure is fed into the demethanizer.
6. The natural gas liquid plant of claim 1 wherein part of the vapor portion is expanded in a turboexpander and fed into a second separator that produces a liquid that is employed as a lean demethanizer reflux and a vapor that is fed into the absorber.
7. The natural gas liquid plant of claim 1 wherein ethane recovery is at least 85 mol% and propane recovery is at least 99 mol%.

8. The natural gas liquid plant of claim 1 wherein the first and second coolers and the absorber are installed as an upgrade to an existing plant.
9. A natural gas liquid plant, comprising:
  - a primary and secondary cooler that cool a low pressure feed gas, and a separator that separates the cooled low pressure feed gas in a liquid portion and a vapor portion;
  - a first pressure reduction device that reduces pressure of the liquid portion, thereby providing refrigeration for the secondary cooler;
  - a third cooler that cools at least part of the vapor portion, wherein the cooled vapor portion is expanded in a pressure reduction device; and
  - an absorber that receives the cooled and expanded vapor portion and produces an overhead product that provides refrigeration for the third cooler and a bottom product that is employed as reflux in a demethanizer.
10. The natural gas liquid plant of claim 9 wherein the low pressure feed gas is at least partially dehydrated and has a pressure of between about 300 psig and about 1000 psig.
11. The natural gas liquid plant of claim 9 wherein the first pressure reduction device comprises a hydraulic turbine and wherein the second pressure reduction device comprises a Joule-Thompson valve.
12. The natural gas liquid plant of claim 9 wherein a portion of the low pressure feed gas is cooled in a plurality of side reboilers that are thermally coupled to the demethanizer.
13. The natural gas liquid plant of claim 9 wherein part of the vapor portion is expanded in a turboexpander and fed into a second separator that produces a liquid that is employed as a lean demethanizer reflux and a vapor that is fed into the absorber.
14. The natural gas liquid plant of claim 9 wherein the primary cooler employs as least one of external ethane, external propane, and the absorber overhead product as a refrigerant.

15. The natural gas liquid plant of claim 9 wherein ethane recovery is at least 85 mol % and propane recovery is at least 99 mol%.
16. A natural gas liquid plant comprising a separator receiving a cooled low pressure feed gas and fluidly coupled to an absorber and a demethanizer, wherein refrigeration duty of the absorber and demethanizer are provided at least in part by expansion of a liquid portion of the cooled low pressure feed gas and an expansion of a vapor portion using a device other than a turboexpander.
17. The natural gas liquid plant of claim 16 wherein the cooled low pressure feed gas has been cooled by a cooler that employs an expanded liquid portion of the cooled low pressure feed gas as a refrigerant.
18. The natural gas liquid plant of claim 16 wherein the absorber produces an absorber bottom product that is fed to the demethanizer as reflux.
19. The natural gas liquid plant of claim 16 wherein the separator separates a vapor portion from the cooled low pressure feed gas and wherein a first part of the vapor portion is further cooled via a Joule-Thompson valve and introduced into the absorber.
20. The natural gas liquid plant of claim 19 wherein a second part of the vapor portion is expanded and cooled in a turboexpander.

## AMENDED CLAIMS

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What is claimed is:

1. A natural gas liquid plant, comprising:  
  
a separator that separates a cooled low pressure feed gas into a liquid portion and a vapor portion, wherein the liquid portion is reduced in pressure in a first pressure reduction device, thereby providing refrigeration for a first cooler that cools a low pressure feed gas thereby forming the cooled low pressure feed gas;  
  
wherein at least part of the vapor portion is cooled in a second cooler and reduced in pressure in a second pressure reduction device before entering an absorber as lean absorber reflux; and  
  
wherein the absorber produces an absorber overhead product that provides refrigeration for the second cooler, and wherein the absorber produces an absorber bottoms product that is fed into a demethanizer as lean reflux.
2. The natural gas liquid plant of claim 1 wherein the low pressure feed gas has a pressure of about 300 psig to about 1000 psig.
3. The natural gas liquid plant of claim 1 wherein a portion of the low pressure feed is cooled in a plurality of side reboilers that are thermally coupled to the demethanizer.
4. The natural gas liquid plant of claim 1 wherein the first pressure reduction device comprises a hydraulic turbine, and wherein the second pressure reduction device comprises a Joule-Thompson valve.
5. The natural gas liquid plant of claim 1 wherein the liquid portion that is reduced in pressure is fed into the demethanizer.
6. The natural gas liquid plant of claim 1 wherein part of the vapor portion is expanded in a turboexpander and fed into a second separator that produces a liquid that is employed as a lean demethanizer reflux and a vapor that is fed into the absorber.

7. The natural gas liquid plant of claim 1 wherein ethane recovery is at least 85 mol% and propane recovery is at least 99 mol%.
8. The natural gas liquid plant of claim 1 wherein the first and second coolers and the absorber are installed as an upgrade to an existing plant.
9. A natural gas liquid plant, comprising:
  - a primary and secondary cooler that cool a low pressure feed gas, and a separator that separates the cooled low pressure feed gas in a liquid portion and a vapor portion;
  - a first pressure reduction device that reduces pressure of the liquid portion and thereby provides refrigeration for the secondary cooler;
  - a third cooler that cools at least part of the vapor portion, wherein the cooled vapor portion is expanded in a pressure reduction device; and
  - an absorber that receives the cooled and expanded vapor portion and produces an overhead product that provides refrigeration for the third cooler and a bottom product that is employed as reflux in a demethanizer.
10. The natural gas liquid plant of claim 9 wherein the low pressure feed gas is at least partially dehydrated and has a pressure of between about 300 psig and about 1000 psig.
11. The natural gas liquid plant of claim 9 wherein the first pressure reduction device comprises a hydraulic turbine and wherein the second pressure reduction device comprises a Joule-Thompson valve.
12. The natural gas liquid plant of claim 9 wherein a portion of the low pressure feed gas is cooled in a plurality of side reboilers that are thermally coupled to the demethanizer.
13. The natural gas liquid plant of claim 9 wherein part of the vapor portion is expanded in a turboexpander and fed into a second separator that produces a liquid that is employed as a lean demethanizer reflux and a vapor that is fed into the absorber.

14. The natural gas liquid plant of claim 9 wherein the primary cooler employs as least one of external ethane, external propane, and the absorber overhead product as a refrigerant.
15. The natural gas liquid plant of claim 9 wherein ethane recovery is at least 85 mol% and propane recovery is at least 99 mol%.
16. A natural gas liquid plant that comprises a separator receiving a cooled low pressure feed gas and fluidly coupled to an absorber and a demethanizer, wherein refrigeration duty of the absorber and demethanizer are provided at least in part by expansion of a liquid portion of the cooled low pressure feed gas and an expansion of a vapor portion using a device other than a turboexpander.
17. The natural gas liquid plant of claim 16 wherein the cooled low pressure feed gas has been cooled by a cooler that employs an expanded liquid portion of the cooled low pressure feed gas as a refrigerant.
18. The natural gas liquid plant of claim 16 wherein the absorber produces an absorber bottom product that is fed to the demethanizer as reflux.
19. The natural gas liquid plant of claim 16 wherein the separator separates a vapor portion from the cooled low pressure feed gas and wherein a first part of the vapor portion is further cooled via a joule-Thompson valve and introduced into the absorber.
20. The natural gas liquid plant of claim 19 wherein a second part of the vapor portion is expanded and cooled in a turboexpander.